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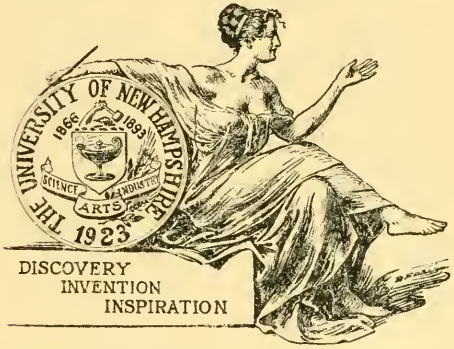

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Bulletin 192 June, 1919

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

REPORT

OF THE

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING JUNE 30, 1918

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

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BETTY I. GLIDDEN, *Stenographer.*

REPORT OF THE DIRECTOR.

During the period covered by this report, there was raging in Europe the greatest conflict of arms that the world has ever known. Even though we were thousands of miles from the trenches, there were few lives and few institutions in this country that were not affected and influenced by the war. It is a bright page in the history of our country that records the patriotic response of the American farmer to the call for increased food production. "Food Will Win the War" was a direct challenge to the patriotism of our farmers, to which they responded nobly. In spite of the decreasing and inferior labor supply for which the farmer had to compete with other industries that were paying war prices, the unusually high cost of seeds, fertilizers, implements, machinery and parts, to say nothing about the uncertainty of prices which he might expect for his crops, he went ahead and planted bumper crops. The country needed food to win the war, and the American farmers were determined it should be forthcoming.

It is natural that the farmers should turn to the College and Experiment Station for even more assistance during a time like this, when there is so much more risk involved, and when to make a mistake would mean greater financial loss than it would during normal times. The requests for advice sent to the New Hampshire Experiment Station covered a very wide range of subjects with innumerable variations. Fortunately the Station had been able to acquire gradually during past years a large amount of data and information relating to the agriculture of the state which it could supply at once and thereby render a valuable service not only to the individual farmer but to the state and the nation in helping to carry out the war program.

As the pre-war work of the Station had prepared for meeting the needs under emergency conditions, it was felt that in so far as possible even under the stress of war, the future should not be lost sight of, and it has been the policy to continue with the minimum interruption the long-time and most important Experiment Station projects. This has been difficult owing to the many demands which have been made upon the members of the staff to assume new duties. In order that there might be unity of purpose and the greatest efficiency in directing and carrying out the food production campaign in the state, there was created a State Food Production Committee which included, in its membership, representatives from the leading official and voluntary agencies of the state directly concerned with food production. The Emergency Food Production Committee consisted of:

Huntley N. Spaulding, Federal and State Food Administrator.
R. D. Hetzel, President, New Hampshire College.
Andrew L. Felker, Commissioner of Agriculture.
Fred A. Rogers, Master, State Grange.
George A. Putnam, President, Federated Farm Bureau Association.
George H. Whitcher, Deputy Superintendent of Public Instruction.

Mr. Spaulding was made Chairman of the Committee, and President Hetzel was made Executive Manager. Members of the Station staff served as an Advisory Committee, and many of them were required to do a good deal of field work.

Prof. J. H. Gourley was given charge of the state city war garden work in twenty cities and towns. The urban garden work was divided into the home, city, and factory gardens. Garden supervisors were employed in several cities. Four city garden supervisors were employed co-operatively by the city or some corporation or local committee, and the Federal Government. The work of these agents was carried on in co-operation with the Extension Service of the college through the Farm Bureaus. Over 2,000 acres were planted in gardens in these cities and towns which represented an increase of 75 per cent over the area planted the previous year.

Prof. W. C. O'Kane served as Assistant Executive Manager and gave a large amount of time to lecture work.

Mr. B. E. Curry assisted the State Committee in handling problems connected with farm machinery and money loans to farmers.

Dean F. W. Taylor handled the problems relating to seeds and fertilizer.

The Director of the Station besides serving on the Advisory Committee was Chairman of the Live Stock Group, consisting of Messrs. Eckman, Richardson, Ritzman and Fuller. He also had charge of a survey in the state of wheat harvesting, thrashing, and grinding facilities which had been brought into prominence through the increased interest aroused in wheat growing. While the volume of wheat grown in New Hampshire last season was not large, it represented an increase of over 400 per cent above what it had been in 1917. Most of the areas planted to wheat were small, and many planted the crop for the first time, thus creating a big demand for information on all phases of growing, harvesting, and milling wheat. A survey of the results of the Emergency Food Production Campaign, including over 50 per cent of the farms in all parts of the state, indicates an increased acreage over 1917 of over 32 per cent for potatoes, beans, corn, and small grains.

Aside from giving a large amount of time to committee work, the members of the Station staff were called upon to devote more time than usual to lecture work and other requests for assistance in the state program from county agents, farmers, and organizations.

The Experiment Station representatives prepared manuscripts for twenty press bulletins and six circulars which were issued in connection with the State Food Production Campaign and distributed in editions totaling 543,000. There is also a record of forty-three special press articles that were prepared by members of the Experiment Station staff in connection with the drive to increase the amount of food produced in New Hampshire in 1918.

There were some changes in the personnel of the Station staff due directly or indirectly to the war. Mr. Curry, Station Chemist, was granted a leave of absence to take up chemical work for the Army Ordnance Department. Mr. J. R. Hepler, Assistant in Vegetable Gardening, was given a commission as Second Lieutenant in the Quartermaster Corps. Mr. K. B. Laird, Assistant Botanist, joined the military service, and Mr. Ford S. Prince, Assistant Agrono-

mist, left the Station to take up extension work in Ohio. In addition to the above changes, Mr. Harry P. Young, Assistant Agronomist, has taken up work in Farm Management at Cornell University, and Mr. W. L. Doran, Assistant Botanist, resigned to take up work with the Government. Mr. E. G. Ritzman, Animal Husbandman, spent a period of service at Plattsburg. It has been difficult to find men to fill these vacancies and to continue some of the regular Station activities. In spite of the interruptions and changes incidental to the war, the regular Station program has been maintained without material change that would seriously affect continuing the work when normal conditions have returned.

The College and Station have derived unexpected benefit as a result of having a Vocational Training Detachment located at the College. Several buildings of which the institution was badly in need have been erected. A new model poultry plant was built and makes a valuable addition to the equipment and facilities of the Poultry Department. A new and up-to-date piggery will furnish accommodations for future work in pork production. A wagon and machinery shed and shop has been constructed for the Farm Department, two large dormitories, a Y. M. C. A. building, an ell on the Gymnasium, additions to the shops, and much needed cement walks to connect the main buildings on the campus are some of the improvements which have been made this year.

The war has helped to bring about a much closer relationship than ever existed before between the members of the Experiment Station staff, the Extension force, and the public. There has developed a new respect and more confidence on the part of the public in established agencies and their work, since they have proven their value during the national crisis. The Experiment Station faces the reconstruction period with a new feeling of confidence and with the ambition to improve upon its past record of accomplishment. An indication of the high regard in which New Hampshire College and its work is held by the people of the state is shown by the large attendance at the Field Meeting held at the College last summer, where there was an attendance of over five thousand people from all parts of the state.

The rapid development of extension activities under the stress of war conditions has only served to emphasize the close relationship which must exist between the Extension force in the field and the investigator at the Station. The Extension force is continually bringing new problems direct from the farmer to the Station to be solved or explained by the trained specialist, and the Experiment Station is freely giving from its store of accumulated knowledge reliable advice and assistance, meanwhile attacking new problems to meet new issues and to prepare for the future drafts which are sure to be made upon its resources. This is as it should be, and serves to emphasize the wisdom and farsightedness displayed by the authors of the Federal Hatch and Adams Acts, and the more recent Smith-Lever Law which provides so well for the accumulation of authentic information by our Experiment Stations, and a very efficient agency, our Extension Services, through which to distribute and make readily accessible where most needed the accumulated knowledge of State and Federal agencies and institutions.

While War Emergency Work has retarded and interfered with the best

progress of Station work, in most all of the departments the Station organization has been maintained with comparatively few changes, and the most important Station projects have been continued without any material modifications. In fact, instead of neglecting their obligations to the investigations in their charge under the stress of the times and the numerous and varied demands upon them for taking up new and outside duties, the members of the Station staff have carried the extra burden in addition to performing their regular work. In other words, the war work has been made possible by a general speeding up all along the line, and it is to the credit of the Station force that they have met this issue in such a willing, whole-hearted, and public-spirited manner. Every one connected with the Station has demonstrated his patriotism and earnest desire to do everything within his power to aid the State and Nation in carrying out the war program.

PRINCIPAL INVESTIGATIONS AND EXPERIMENTS CARRIED ON DURING THE YEAR.

Hatch Fund.

Department of Agronomy.

(a) Variety tests of ensilage corn.
(b) Variety tests of field beans.
(c) Variety tests of small grains.
    (1) Spring wheat.
    (2) Barley.
    (3) Oats.
(d) Timothy selection.

Department of Botany.

(a) The control of the white pine blister rust on ribes.
(b) Snapdragon rust and its control.
(c) Effect of temperature on the keeping quality of potatoes.

Department of Entomology.

(a) An investigation of the apple leaf miner and its reaction to application of contact insecticides.
(b) Control of black flies
(c) Insect record.

Department of Forestry.

(a) Experiments in establishing artificial forests of different species in New Hampshire.
(b) Experiments in immature white pine stands.

Department of Horticulture.

(a) Variety tests of apples, plums and small fruits.
(b) Study of the status of the blueberry industry in the state.
(c) Miscellaneous projects.
    (1) Adaptation of varieties of tomatoes to New Hampshire conditions.
    (2) Experiment on use of manures, commercial fertilizers and green crops for maintaining soil fertility in vegetable garden.
    (3) Experiment on storage pits and trenches for root crops and cabbage.

Adams Fund.

Department of Animal Husbandry.

(a) Sheep breeding.

Department of Botany.

(a) Studies on the effects of fungicides and insecticides on plants.
  (1) Cuprammonium washes.
  (2) Bordeaux mixture.
(b) Structure of the fruit spur of the apple.
(c) Chemical studies of the apple.
(d) A study of the toxic action of fungicides.

Department of Chemistry.

(a) Chemical studies of the apple (in co-operation with the Botany Department).
(b) Studies on the effects of fungicides and insecticides on plants (in co-operation with the Botany Department).
(c) The relation of potassium to the growth of the cereals.

Department of Entomology.

(a) Control of root maggots by insecticides.

Department of Horticulture.

(a) Fruit bud formation.
(b) Plant breeding.
  (1) Inheritance of color in carnations.
  (2) Mendelian inheritance in squashes.

PUBLICATIONS WRITTEN BY MEMBERS OF THE STATION STAFF DURING THE YEAR.

During the year twenty press bulletins were prepared by members of the Station staff and were circulated to the number of 400,000. Fourteen extension circulars were prepared with a circulation of 280,000, and forty-one articles for press publication were sent out. In addition to these the following Experiment Station bulletins were prepared and printed:

No. 183—Arsenical Residues after Spraying.
No. 184—Food Stuffs.
No. 185—Fertilizer Inspection.
No. 186—Seed Tests for 1917.
No. 187—Food Stuffs for 1918.
No. 188—Seed Tests for 1918.
No. 189—Fertilizers.

Circular No. 19—Potato Seed Certification in New Hampshire.
Technical Bulletin No. 12—Some Observations on the Growth of Apple Trees, by J. H. Gourley.
Technical Bulletin No. 13—Physiology of the Apple, by O. R. Butler, T. O. Smith, and B. E. Curry.

The following scientific papers have also been published:

Butler, O.—The Cuprammonium Washes, Their Preparation, Biological Properties, and Application. Phytopathology, *7:* 235–268, 1917.
Butler, O.—On the Preservation of Phytopathological Specimens in Their Natural Colors. Phytopathology, *8:* 66–68, 1918.
Ritzman, E. G.—Nature and Rate of Growth in Lambs During the First Year. Journal of Agricultural Research, Vol. XI, No. 11.
Ritzman, E. G., and Davenport, C. B.—Family Performance as a Basis for Selection in Sheep. Journal of Agricultural Research, Vol. X, No. 2.
Ritzman, E. G.—A Chest Contour Caliper and Its Applicability for Measuring Lambs. N. H. Agricultural Experiment Station, Scientific Contribution No. 11.

Butler, O.—The Effect of the Environment on the Loss of Weight and Germination of Seed Potatoes During Storage. Journal of the American Society of Agronomy, *11:* No. 3, 114–118, March, 1919.

ANNUAL REPORT TO THE UNITED STATES GOVERNMENT OF THE HATCH FUND.

For the year ending June 30, 1918.

RECEIPTS.

Cash received from United States treasurer	$15,000.00

EXPENDITURES.

Cash paid for salaries	$9,318.65
labor	956.53
publications	2,019.02
postage and stationery	884.60
freight and express	280.57
heat, light, water, and power	600.00
chemicals and laboratory supplies	14.56
seeds, plants, and sundry supplies	207.50
fertilizers	21.00
feeding stuffs	216.55
library	181.28
tools, machinery, and appliances	116.33
scientific apparatus and specimens	2.20
live stock	2.00
traveling expenses	158.21
contingent expenses	21.00
	$15,000.00

ANNUAL REPORT TO THE UNITED STATES GOVERNMENT OF THE ADAMS FUND.

For the year ending June 30, 1918.

RECEIPTS.

Cash received from United States treasurer	$15,000.00

EXPENDITURES.

Cash paid for salaries	$10,097.35
labor	2,643.27
postage and stationery	13.50
freight and express	1.50
chemicals and laboratory supplies	148.92
seeds, plants, and sundry supplies	375.26
fertilizers	308.79
feeding stuffs	611.76
library	1.26
tools, machinery, and appliances	44.45
scientific apparatus and specimens	136.55
traveling expenses	148.53
buildings and land	468.86
	$15,000.00

SUPPLEMENTARY STATEMENT OF FUNDS RECEIVED BY THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION FROM OTHER SOURCES THAN THE UNITED STATES.

For the fiscal year ending June 30, 1918.

	Sales.	*Miscellaneous.*	*Total.*
Balance on hand June 30, 1917	$134.57	—	$134.57
Receipts from other sources than the United States for the year	764.11	$10,150.05	10,914.16
Total	$898.68	$10,150.05	$11,048.73
Cash paid for salaries	—	$1,024.92	$1,024.92
labor	$440.94	3,655.96	4,096.90
publications	—	1,591.22	1,591.22
postage and stationery	4.66	513.86	518.52
freight and express	58.92	28.19	87.11
heat, light, water, and power	—	214.44	214.44
chemicals and laboratory supplies	—	381.65	381.65
seeds, plants, and sundry supplies	244.13	684.15	928.28
feeding stuffs	43.48	228.55	272.03
library	—	24.59	24.59
tools, machinery, and appliances	5.93	97.38	103.31
furniture and fixtures	—	301.46	301.46
scientific apparatus and specimens	—	74.79	74.79
live stock	—	425.00	425.00
traveling expenses	60.62	855.22	915.84
contingent expenses	—	5.50	5.50
buildings and land	40.00	43.17	83.17
Total	$898.68	$10,150.05	$11,048.73

REPORT OF THE DEPARTMENT OF AGRONOMY.

F. W. TAYLOR.

During this year both assistants in the Department resigned,—one on May 1 to accept an appointment as county agent of Green County, Ohio, and the other on October 1 to accept a fellowship at Cornell University. The Department was without the services of an assistant until November 1.

The time of the members of the Department was divided during the year as follows:

	College	*Station, Hatch*
Head	7 tenths	3 tenths
First Assistant	5 tenths	5 tenths
Second Assistant	6 tenths	4 tenths
Present Assistant	6 tenths	4 tenths

It is impossible to state the exact number of letters of inquiry answered during the year, but a conservative estimate would place it at about 2,500, this work entailing at least one-fourth of the time of the men.

One hundred and thirty-six persons were enrolled in the two reading courses offered by the Department. The handling of this work, especially the reading and correction of the papers, required considerable time.

During the season of 1918 some thirty or forty public addresses were given by the members of the Department, primarily as a war measure, on food production. One regular Bulletin No. 188, and eight Press Bulletins, Nos. 92, 94, 95, 96, 97, 98, 102 and 111, were published during the year.

The work in seed testing included 270 official samples collected by the state commissioner of agriculture and 475 samples sent in by farmers, county agents and seed dealers.

HATCH PROJECTS.

Timothy Selection.

This work was begun in 1914. The object was to make a selection from individual plants of the best and largest yielding strains. Twenty-four hundred different plants have been grown and recorded. During the summer of 1918 a twentieth-acre plot was sown with the seed from twenty of the best timothy plants. This plot will furnish seed for a small field to be sown in the fall of 1919.

Variety Tests of Ensilage Corn.

Ten strains or varieties of ensilage corn were grown for a comparison of yields and general adaptability. Confirming the results of previous years it was apparent that the medium and earlier varieties like Leaming and N. H. 500 were best suited to this section.

Variety Tests of Field Beans.

Twelve varieties of field beans were grown with yields as high as eighteen bushels per acre. The yellow-eye and red kidney gave the best results.

Variety Tests of Small Grains.

The following small grains were sown on one-thirtieth acre plots in the spring of 1918:

1. Three varieties of spring wheat;
2. Four varieties of barley;
3. Thirteen varieties of oats;
4. Eight varieties of winter wheat.

The average yield of the wheats was 18 bu. per acre, and the best was the Marquis with 22.1 bu. The average of the barleys was 46.5 bu. per acre; the largest was Vermont Champion, a two-row sort yielding 49.5 bu. The oats proved an exceptional and fine crop. The thirteen varieties yielded 53.6 to 86 bu. per acre, "Swedish Select" standing highest with "Worthy" second. The weight per bushel of all but two of the varieties was 32 lbs. or over.

The varieties of winter wheat were sown in the fall of 1918. Two of these were being sold by New England seedsmen and six of them were high yielding sorts secured from the Ohio Experiment Station. The object of the test was to determine the most promising variety for local production.

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY.

E. G. RITZMAN.

DEPARTMENT ORGANIZATION.

Owing to the basis on which this Department is operating it has had only two regular or permanent employees, namely, an animal husbandman and a shepherd. In view of this limitation in assistance, both in the office and outside, a considerable amount of work has been done by hiring extra day labor.

In this Department there is no division of time between Station and College work as all of the time of the force is primarily given to Station work.

Correspondence has been mainly of a routine nature such as answering letters asking for information on management, feeding, etc., of live stock. A considerable amount of correspondence has been engaged in by the animal husbandman in the capacity of secretary-treasurer of the New Hampshire Sheep Breeders' Association. This consists in a large measure of answering letters asking for information on management and breeding of sheep. Probably less than one-tenth time has been necessary for all correspondence.

Field work was also done in the form of lectures given in behalf of the emergency food production campaign.

Three technical articles were published during the year. Two of these, namely, on "Nature and Rate of Growth in Lambs," and on "Family Performance as a Basis for Selection in Sheep," were printed in the *Journal of*

Agricultural Research; the third, on "A Chest Contour Caliper and Its Adaptability for Measuring Sheep," was issued as a Station circular.

In addition to this, two practical bulletins, one on "Sheep Breeding in New Hampshire" and the other on "The Sheep Industry in New Hampshire," were published in behalf of the New Hampshire Sheep Breeders' Association. An article on "Raising Beef in New Hampshire" was prepared for the report of the state commissioner of agriculture, and one circular, numerous timely articles for the press, and one poster prepared by the animal husbandman for the food production campaign were published during the year.

The Department has two co-operative projects in research with the Carnegie Institution of Washington. In the first of these, the sheep breeding experiments, the co-operation is purely of a consulting nature on the part of Dr. C. B. Davenport representing the Station for Experimental Evolution of the Carnegie Institution. In the second of these, the nutrition experiment, the co-operation involves equal financial obligations.

While the activity of the animal husbandman as secretary-treasurer of the New Hampshire Sheep Breeders' Association is not co-operative, a considerable amount of work was done in the organization and education of farmers on subjects relative to the sheep industry and its improvement, thus relieving the Station from similar work.

No special equipment has been added except the chest contour caliper which was designed by the Department and built here.

All of the projects are carried on under the Adams and miscellaneous funds.

SHEEP BREEDING EXPERIMENTS.

History of Experiment.

The experimental work with sheep, as originally planned (1906) and carried out by F. W. Taylor and E. L. Shaw, consisted in the production of spring lambs for market.

In 1908 this early lamb project was revised by W. H. Pew and E. D. Sanderson with the object, first, "to determine the principles involved and the best methods to be employed in grading up a flock of sheep, particularly for early lamb production, studying the characters of crosses with reference to Mendel's Law"; second, "to determine the principles involved in fixing certain characters in sheep, studying the closeness with which the characters of the hybrids follow Mendel's Law and their application to breeding problems."

During the first two years following the revision of this project the majority of lambs were fitted and sold for early market so that the project as a breeding experiment lost its value from a Mendelian point of view.

Following this period the work was for two years under the direction of T. R. Arkell, who gave more attention to the problems relating purely to inheritance. At this time the main work consisted in hybridization along Mendelian lines of the Hampshire and Rambouillet breeds, and a bulletin was issued on the method of transmission or inheritance of horns in sheep. Some Hatch work in feeding on "Feeding Sheep and Lambs: Clover Hay *v.* Native Hay; Turnips *v.* Dry Ration" was also made public in the form of a Station bulletin.

In 1913 the project was again revised under the direction of J. M. Jones in co-operation with C. B. Davenport.

Under the revised project a new schedule was added in a cross between Southdown and Rambouillet to be carried out along Mendelian lines of hybridization.

The object as stated was "to determine the principles involved in fixing certain characters in sheep, studying the closeness with which the characters of the hybrids follow Mendel's Law, and their application to breeding problems."

Under this revised project the work is still being carried on although minor changes have been made, such as adding new methods and a general broadening in the scope of the data collected.

Progress.

The present head of the Department has been in charge of this work since February, 1915. Up to that time a mass of material had already been collected but, aside from the publication of the bulletin on the "Inheritance of Horns in Sheep," no information of technical importance had been worked out or published.

Since February, 1915, several lines of investigation have been worked up and published under the following titles:

1. Mendelism of Short Ears in Sheep.
2. Ewes' Milk; Its Fat Content and Relation to Growth of Lambs.
3. Nature and Rate of Growth in Lambs During the First Year.
4. Family Performance as a Basis for Selection in Sheep.
5. A Chest Contour Caliper and Its Adaptability for Measuring Sheep.

An article on conformation of Rambouillet and Southdown sheep and on their F_1 and F_2 Hybrids is under preparation and will be published within a year, and a number of articles of a technical nature, on the inheritance of conformation, especially as regards chest contour or shape, on wool covering, inheritance of color, skin folds, ear posture, and wool characters are outlined and will be put into print as soon as the material can be worked up.

The Hampshire-Rambouillet cross has reached the F_4 generation and is now being gradually eliminated, partly by dissemination of the better stock among farmers, and the Southdown-Rambouillet cross is now at the beginning of the F_2 stage where sufficient numbers are becoming available for studying the results of segregation.

After this has reached the stage where a more rigid selection of stock can be made, only those individuals that possess the desired combination of traits are to be retained as a flock foundation of a new type and a greater amount of attention will be given to a study of the inheritance of the causes of twin inheritance and the milk yield of ewes which are fundamentally the important factors that determine profit in a lamb crop.

NUTRITION EXPERIMENTS.

During the fall of 1918 the work of the Department was broadened by the addition of research work in animal nutrition, especially relating to the maintenance of animals during the winter period.

On the suggestion of Dr. F. G. Benedict of the Nutrition Laboratory of the

Carnegie Institute a co-operative experiment in basal metabolism with cattle was started, and a splendid opportunity was offered to work out, at the same time, some problems having a direct bearing on winter feeding of beef animals (steers) with special reference to the influence of maintenance and submaintenance rations.

The general character of this experiment was planned to cover "the influence of maintenance and submaintenance rations in the wintering of steers and their effects on subsequent fattening of farm animals for market" both on pasture and on dry rations.

Twelve steers were purchased for this purpose and a part of one of the sheep barns was remodeled to suit the needs of the experiment. No details can be given regarding progress up to the present time.

STEER FEEDING EXPERIMENT.

History of Experiment.

The question of raising and feeding beef cattle in New Hampshire has been a matter of some concern to many of our farmers. While this section of the country cannot become a competitor in beef production with the corn belt, where the feeding industry to market grain in the form of beef is of primary importance, there are other fundamental reasons for a greater increase in our live stock.

These are, first, soil fertility; second, marketing of surplus hay, especially those grades which often have a low market value; and, third, to make use of some of our unused grazing lands.

In the fall of 1917 several carloads of Hereford steer and heifer calves, averaging about six to ten months of age, were brought here from Texas by local farmers, primarily with the object to feed up hay which at that time had a very low market value.

The Animal Husbandry Department at that time had the opportunity to study the same problem as a co-operative project with the Horticultural Department under a condition very typical throughout the state.

The latter department had about ten tons of hay representing a very low market value. In fact the cost of baling, haul to station, freight, etc., would hardly have been repaid, had there been any market demand for that type of hay at all. Furthermore, that department was in great need of manure which it was obliged often to haul such distance as to make manure very expensive. The following co-operative agreement was therefore entered into:

Co-operative Agreement.

"The Animal Husbandry Department of the Station is to have full advisory control on the method of conducting the feeding test and to supply the stock and the grain and to pay the Horticultural Department a fair market price for the hay used. The Horticultural Department is to furnish the barn, running water and necessary labor in exchange for the manure accumulated during the indoor feeding period. Any balance is to be adjusted on an equitable basis between value of labor and value of manure."

The object of the experiment is:

1. To find what returns can be obtained for ordinary native hay when fed to beef type of cattle.

2. To determine whether the fertility value of the manure accumulated during the winter would balance the labor necessary for their care during this period.

3. Whether a satisfactory growth can be maintained during the winter in calves of this age, from ordinary native hay supplemented with a limited grain ration.

Progress and Results Obtained.

The experiment was begun on December 1, 1917, with ten steer calves averaging 343 pounds in weight.

In planning the ration it was assumed that the most profitable returns would be obtained from the hay if balanced with sufficient of a highly nitrogenous concentrate to offset the low protein content of the hay used. This result was theoretically obtained by giving, per head, 3 pounds of a meal mixture consisting of 2 parts cottonseed meal and 1 of wheat bran. The animals were carried on this ration of meal with all the hay they would eat from December 1, 1917, to May 15, 1918, after which they were put on pasture till October 26, 1918.

During the summer, or pasture period, the net profit, as calculated on increase in live weight and on the basis of current market values, was about $27 per head.

A bulletin giving the financial statement covering the operation for the year has been prepared for publication.

As the steers are only eighteen months of age it was deemed advisable not to fatten them for market at this time but to continue the operation for another year.

REPORT OF THE DEPARTMENT OF BOTANY.

O. R. BUTLER.

During the fiscal year ending June 30, the work of the Department was mainly carried by the botanist, the position of assistant botanist, which became vacant with the resignation of Mr. W. L. Doran on November 1, 1917, not being filled during the remainder of the year.

As in previous years the correspondence of the Department related mainly to the diseases of our economic plants and their control, and the number of inquiries received indicated an increasing realization of the value of this service by the farmers of the state.

During the course of the year, the disease survey carried on in collaboration with the Plant Disease Survey, United States Department of Agriculture, was more fully developed than hitherto and supplied much useful and valuable information on the relative distribution and economic importance of parasitic fungi.

The research work carried on was as follows:

A—ADAMS PROJECTS.

1. Studies on the Effects of Fungicides and Insecticides on Plants.

(a) *Cuprammonium Washes.*—During the year work on the methods of preparation, biological properties, and application of the cuprammonium washes was completed, the conclusions derived from the completed study being briefly as follows:

The cuprammoniums met with in practice belong, chemically, in one or the other of the following groups: (1) cuprammonium sulphate; (2) cuprammonium hydrate; and (3) cuprammonium carbonate.

When decomposed by drying cuprammonium sulphate deposits the copper as a basic sulphate, cuprammonium hydrate yields a copper hydrate, and cuprammonium carbonate, a copper carbonate.

Cuprammonium sulphate is very unstable; cuprammonium hydrate and carbonate, very stable.

The cuprammoniums are more toxic when slowly than when quickly dried.

The toxicity of the cuprammoniums during drying and on weathering is due to soluble copper.

The copper sulphate and ammonia wash and Johnson's mixture are less injurious than the malchite washes.

The cuprammonium washes are more effective and efficient than Bordeaux mixture when large amounts of soluble copper are required to give protection.

The cuprammonium washes are less effective than Bordeaux mixture when small amounts of soluble copper suffice to give protection but with the exception of the malchite-ammonium carbonate wash are slightly more efficient.

The relative efficiency of the unit copper in the cuprammoniums is in decreasing order as follows: copper sulphate-ammonia, malchite-ammonia, copper sulphate-ammonium carbonate, malchite-ammonium carbonate.

The cuprammoniums may be used at 11.7 times their lethal concentration for *Plasmopra viticola* on plants not affected by 0.0075 per cent soluble copper.

The cuprammoniums are of limited practical applicability and should not be used in lieu of Bordeaux mixture whenever the latter yields sufficient soluble copper to give protection.

(b) *Bordeaux Mixture.*—During the past year studies on the stimulating action of Bordeaux mixture have been continued and the results obtained indicate that:

Transpiration is increased by spraying with 1 per cent Bordeaux mixture in which the ratio copper sulphate to lime is unity.

The increased transpiration is not due to the copper salt, but to the excess of lime.

One per cent Bordeaux mixture 1:1 does not stimulate plant growth but rather has a depressing effect which, however, is more marked in weak than strong light.

Soil fertility is without effect on the stimulatory action of Bordeaux mixture.

(c) *Relative Adhesiveness of the Copper Fungicides* (in collaboration with Mr. T. O. Smith, Department of Chemistry).—Work on this subject has been con-

tinued. Twenty-three copper fungicides and combinations of copper fungicide and insecticides are being studied.

2. Structure of the Fruit Spur of the Apple.—Work on the histology of the fruit spurs of the apple has been delayed owing to Mr. Doran's resignation on November 1, last. We have, however, found that the opinion current in the literature that the *lambourde* type of fruit spur is more perishable than the *dard* type is morphologically sound, as is also the opinion that a *dard* developing on a *lambourde* increases the longevity and vigor of the fruit branch.

3. Chemical Studies of the Apple (in co-operation with the Department of Chemistry).—The work on the distribution of the food materials in the apple tree was concluded during the year; and a summary of the results obtained will be found in the report of the Department of Chemistry.

4. A Study of the Toxic Action of Fungicides.—During the year experiments were made on the toxicity of cuprammonium sulphate, normal cupric acetate, and basic cupric acetate to the uredospores of *Puccinia antirrhini* and the aecidiospores of *Cronartium ribicola*. The relative toxicity of the cuprammonium washes to the spores of *Plasmopra ribicola* was also tested and found to be as follows:

Relative Toxicity of the Cuprammonium Washes and Cupric Sulphate to the Spores of Plasmopara Viticola.

Fungicide Used	Lethal Strength	Solubility of Copper
	Per cent Cu.	Relative Nos.
Malchite-ammonia	0.0033	58.13
Malchite-ammonium carbonate	0.0057	33.33
Copper sulphate-ammonia	0.0027	70.42
Copper sulphate-ammonium carbonate	0.0035	54.34
Cupric sulphate	0.0019	100.00

B—HATCH PROJECTS.

1. The Control of the White Pine Blister Rust on Ribes.—Work on this project has been confined to a determination of the minima, optima and maxima temperatures of aecidiospore and uredospore germination and to several experiments on the time elapsing between aecidiospore germination and uredospore appearance.

2. Snapdragon Rust and Its Control.—Field experiments on the control of the snapdragon by means of dry sulphur showed very clearly that this fungicide was inactive under the temperature conditions prevailing.

3. Effect of Temperature on the Keeping Quality of Potatoes.—In continuation of previous experiments it was found that potatoes can be stored in reduced oxygen with little loss of weight as compared to those in normal air provided the water transpired is removed without too complete dehydration of the atmosphere. An experiment run from January 26 to May 25 gave the following results:

Effect of Reduced Oxygen on Loss of Weight of Potatoes Stored at a Mean Temperature of 9.39° C.

Method of Treatment	Loss of Weight after 90 Days	Loss of Weight after 120 Days
Potatoes in air	8.96 per cent	17.24 per cent
Potatoes in reduced oxygen	1.35 per cent	2.79 per cent

PUBLICATIONS.

Butler, O. The cuprammonium washes, their preparation, biological properties, and application. Phytopathology *7:* 235–268, 1917.

Butler, O. R., Smith, T. O., and Curry, B. E. Physiology of the Apple: Distribution of food materials in the tree at different periods of growth. New Hampshire Agr. Expt. Sta. Tech. Bul. *13:* 21 pp., 1917.

Butler, O. On the preservation of phytopathological specimens in their natural colors. Phytopathology *8:* 66–68, 1918.

——— Treatment of loose smut of oats. New Hampshire Expt. Sta. Extension Press Bul. *99*, 1918.

——— What insecticide shall the potato grower use in Bordeaux mixture? New Hampshire Expt. Sta. Extension Press Bul. 109, 1918.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

T. O. Smith.

The regular annual inspections of commercial feeding-stuffs and commercial fertilizers were made for the State Board of Agriculture. Two hundred eighty-eight samples of feeding-stuffs were analyzed and reported in Station Bulletin No. 187. One hundred forty-seven samples of fertilizers were analyzed and reported in Station Bulletin No. 189.

Considerable chemical work was also done for the people of the State in answer to inquiries requiring the analysis of feeds, fertilizers, soils, spray materials and agricultural products.

ADAMS PROJECTS.

Physiology of the Apple.

The co-operative project with the Department of Botany on the Physiology of the Apple has been completed and published as Technical Bulletin No. 13. The following conclusions regarding the distribution of food materials in the apple tree at different periods of vegetation are based upon the chemical determination of the percentage of saccharose, reducing sugars, starch, ether extract, ash, nitrogen, phosphorus and potassium present in the summer's growth, one-year-old branches, two-year-old branches, three-year-old branches, four-year-old branches, five-year-old branches, trunk, large roots and small roots

of samples taken at five periods of vegetation; namely, dormant, buds swelling, in bloom, cessation of active growth, and leaf-fall:

In the apple tree the carbohydrates are stored in the form of starch and saccharose.

At the awakening of vegetation the hydrolysis of starch is more marked in the two-year-old branches and three-year-old branches than in other parts of the tree, but is not extensive since the supply of carbohydrate material needed by the growing parts is mainly furnished by the hydrolysis of the saccharose stored in the small roots.

During the growing season saccharose accumulates in large amounts in the small roots and in noticeable quantities in the two-year-old branches and three-year-old branches, and coincidentally starch storage occurs in these same parts.

Fats are always present in the apple tree and apparently function as reserve food material since they disappear from the roots during the early stages of growth and accumulate in the one-year-old branches and two-year-old branches.

Reducing sugar is the form of translocation of the carbohydrates. It accumulates toward the awakening of vegetation only in the small roots from which it disappears very largely at the time the tree blooms when it begins to accumulate slowly again until leaf-fall. These variations are due to a translocation upward to the growing parts, which, after the tree has bloomed, become self-supporting and finally contributory of reserve food material to all parts of the tree. Reducing sugar then begins to accumulate in the roots where condensation occurs.

The nitrogenous reserve materials are stored mainly in the younger branches from which they pass to the actively growing regions upon the awakening of vegetation.

Ash is present in greater amount in young than old organs. A translocation of ash occurs from the small roots to the one-year-old branches at the awakening of vegetation, but little or no migration takes place from the large roots or the older branches and trunk. As the new growth develops, the ash accumulated in the one-year-old branches passes into the shoots; and, with the development of an absorbing root system, the ash constituents enter the tree and their presence becomes manifest by a rise in the ash content of the small roots.

The phosphorus required in building new tissues at the awakening of vegetation is mainly obtained from the younger branches.

The translocation of potassium at the awakening of vegetation is limited, but occurs mainly from older parts than those that supply the needed phosphorus and nitrogen.

The Relation of Potassium to the Growth of the Cereals.

The study of the relation of potassium to the growth of the cereals, a project which is also co-operative with the Department of Botany, has been carried on continuously with the view to determining at what time in the growth of the cereals the seedlings require a supply of potassium in addition to that stored in the seed, and also to observe the effects and symptoms of potassium starvation on seedlings of wheat, corn and buckwheat. These seedlings have been

grown in both water and sand cultures. It has been clearly shown that each of the three plants requires a supply of potassium, in addition to that stored in the seed itself, within a few days after germination. The symptoms of potassium starvation have been observed and described for each of the three plants. Practically all of the experimental data has been secured and the project should be completed and submitted for publication at an early date.

REPORT OF THE DEPARTMENT OF DAIRY HUSBANDRY.

J. H. FULLER.

The Dairy Husbandry Department, during the year, had 201 cows on test in the semi-official work. Ninety-three seven-day tests were completed in this period. The Advanced Registry testing is the only Station work conducted by this department.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

W. C. O'KANE.

There has been no change in the personnel of the staff of this Department since the projection of the last report. The entomologist has continued to exercise supervision over the work of the Department in general. Both the entomologist and the assistant entomologist have direct charge of those investigations and experimental projects which will be considered more in detail below.

The Department has, during the period covered by this report, been called upon to carry a rather heavy volume of correspondence. There have been 1,212 letters written by the Department during this time, many of these concerned primarily with inquiries from people all over the state regarding insect injury and requests for information regarding the control of insect pests. There seems to be every year a tendency toward this type of service assuming larger and larger proportions.

Several lectures have been delivered before Grange or other agricultural meetings dealing with the subject of important insect pests and their control in the state. In addition to lectures concerned primarily with insect pests and their control, the entomologist has been called upon to deliver an unusually large number of lectures in all parts of the state in connection with his work as vice-chairman of the Food Production Committee and as manager of the New Hampshire Emergency Food Production Campaign. Both the entomologist and the assistant entomologist, in common with most others during the duration of the war, have been called upon, occasionally, to render special service in connection with various lines of war work.

In addition to his duties as entomologist to the Experiment Station and professor of economic entomology, the entomologist is deputy commissioner of

agriculture, in charge of insect suppression for the state. The lines of this work often approach closely the functions of the Department so that it often becomes particularly advantageous for these two departments to work harmoniously, with activities based upon a co-operative relationship.

Several concrete instances concerning this relationship might be cited, one in particular being the work of control of grasshoppers, which has been carried on in various towns in the state during the summers of 1917 and 1918. In this case members of this Department were called upon for expert technical advice and assistance, working with members of the State Division of Insect Suppression upon this project.

Although not in any way officially connected with the Extension Service, members of this Department are on the list of extension speakers and a great deal of the work, especially during the summer months, has a decided bearing on the extension of agricultural education to the people of the state.

Like many other Station departments, the regular work of this Department has undoubtedly suffered during the period covered in this report because of the war and the demands made upon all Station workers in connection with it. The projection, therefore, of project publications has been possibly somewhat interfered with.

Largely in an effort to assist in the more extensive production of food crops, several press bulletins, dealing with particularly serious insect pests of garden crops and their control, have been prepared and published. These are: Extension Press Bulletin No. 104, "The Stalk Borer," by C. R. Cleveland; Extension Press Bulletin No. 105, "The Rose Chafer or Rose Bug," by C. R. Cleveland; Extension Press Bulletin No. 106, "The Squash Bug," by C. R. Cleveland; Extension Press Bulletin No. 107, "The Striped Cucumber Beetle," by C. R. Cleveland; Extension Press Bulletin No. 108, "The Potato Flea Beetle," by C. R. Cleveland. In addition to these the entomologist has published the regular biennial report of the Division of Insect Suppression for the State Department of Agriculture in form of Circular No. 12, "Report of the Plan and Progress of the Work."

The work of adding to the insect collection has been carried on during the past year as usual, though the pressure of other duties sometimes makes it impossible to do as much of that highly necessary work as might be desired.

Some new spraying appliances have been secured and quite a quantity of special equipment to be used particularly in carrying on the work to be done in connection with the studies of insecticidal properties of pyrethrum and hellebore.

INVESTIGATION UNDER ADAMS FUNDS.

Control of Root Maggots by Insecticides Applied to the Surface of the Soil.

While this part of the investigation of root maggots is carried out as a field study, it follows lines suggested by laboratory work from time to time and is supplemented by such work as occasion arises. Furthermore, although carried out in the field, it is really an intensive study, involving minute detail work.

The investigation of the present season has been laid out along the same lines as that of last year, for two principal reasons: First, because the abundance of the insect species under study, *Phorbia brassicae*, varies from year to year, and this variation is reflected in the detailed records; second, because of seasonal variation in rainfall, wind, storms, and other climatological factors.

During the summer of 1917 the work was carried forward as projected in the last report. The species of insect under study was *Phorbia brassicae*, the common cabbage maggot, which normally is rather abundant on cabbages, turnips and radishes in southeastern New Hampshire, including the fields adjacent to the Experiment Station. As is frequently the case with many species of insects, the cabbage maggot has varying abundance between wide limits and this has influenced the progress of the investigation, sometimes unfavorably, because of an actual scarcity of the species, and, again, favorably, because affording an additional angle on the results of studies.

The studies of subterranean materials, including their killing zone, their rate of progress through soil, under varying conditions, has been brought to a close and awaits publication.

The investigation of the season included in this report and that laid out for the season now beginning is confined to materials applied to the surface of the soil and remaining on the surface, especially tobacco dust, tobacco dust and ground limestone, and flour paste.

As in former seasons, a system of detailed records has been maintained and will be followed during the current year. In all cases actual counts are made of maggots and pupae on or adjacent to the roots of plants. This involves removal of soil and sifting the same and is a rather laborious process; but it gives records that are definite and is infinitely more valuable than dependence on the apparent vigor of plants. Results of this part of the investigation also are awaiting publication.

A second and hitherto untried line of inquiry will be carried out at Durham and is a study of the insecticidal properties of pyrethrum or so-called Persian Insect Powder and its extracts.

It is planned to carry out investigations along the following lines:

Efficiency of material as influenced by fineness of division of the powder.

Influence of dry heat.

Comparative study of contact and stomach poison properties.

Influence of extract with water at various temperatures.

Influence of extract with alcohol and ether.

Each of these lines of studying the subject is to be approached from the viewpoint of insecticidal efficiency with the use of living insects as the determining factor. At the same time it will be proposed to supplement this with chemical analyses wherever the facts ascertained seem to make this desirable.

INVESTIGATIONS UNDER HATCH FUNDS.

The Investigation of the Apple Leaf Miner and Its Reaction to Applications of Contact Insecticides.

This investigation was carried out along the lines projected in the last report. The study was continued throughout the season and yielded many

facts of interest. Through the fall and winter of 1917–18 laboratory experiments were carried out by a co-operative arrangement, whereby Mr. C. A. Weigel, representing the Department, was afforded facilities in the laboratory of the Ohio State University.

The subjects studied in the course of the field work of this investigation included the following:

(a) The relation of the position of the larva within its mine to its reaction to contact insecticides, applied to the surface of the leaf tissue.

(b) The relation of the age of the miner to its reaction to such insecticides.

(c) The mortality of the miner in its egg stage to the application of similar insecticides.

(d) Mortality of the miner in its pupal stage within the mine when contact insecticides are applied to the surface of the leaf tissue.

(e) The relation of varying strengths of contact insecticides to the above reactions.

(f) The general facts covering the penetration of contact insecticides into the cavity made by leaf miners.

(g) The residual effects of insecticidal application on the succeeding generation of the apple leaf miner.

In addition to the above investigation a brief study was made of the reaction of the quince leaf miner under similar conditions. Life history studies of the apple leaf miner were carried out in connection with the investigation. The entire study has yielded results of scientific value and interest. These results will soon be prepared for publication.

Control of Black Flies.

Each season's additional work in control of black flies discloses new phases of the subject which should be studied. The work begun last year and projected for the coming season is intended to disclose the distribution and abundance of various species of black flies in different mountain areas of New Hampshire and at varying times of the year. With this in view collections of larvae are being made at numerous points and records taken as to the relative abundance of the several species in their larval stage.

Insect Record.

The Department maintains, as in former years, a careful cross index, showing the distribution of injurious insects in New Hampshire, their food plants and other data.

The Insecticidal Properties of Hellebore.

A new project, the Insecticidal Properties of Hellebore, has been outlined and investigations will be carried out during the coming summer. This project is intended to be carried along at the same time with the current season's study of pyrethrum, the latter being a part of the Adams Fund Project, Control of Root Maggots by Insecticides.

We propose to carry out inquiry concerning the following properties of powdered hellebore as commonly used and recommended for the control of

leaf or fruit-eating insects, especially those feeding on leaves or fruit that are soon to be used for human food:

Dry Diluents.
Effects of Dry Heat.
Aqueous Extracts.
Alcoholic and Ethereal Extracts.
Repellent Properties.
Poisonous Properties with Relation to Vertebrates.

In carrying out the above inquiries much of the apparatus and methods used in the study of pyrethrum will be available. We have very little knowledge concerning hellebore, although it has been used as an insecticide for many years and is commonly recommended as a safe material to use on plants ready to eat. Since we have no material that is known to be effective and entirely safe for use under such conditions, further information of an accurate nature concerning hellebore would be of considerable value.

REPORT OF THE DEPARTMENT OF FORESTRY.

K. W. WOODWARD.

The war deprived the head of the Department of his assistants, and during this period he was the only man at the College engaged in forestry instruction and experimental work. About 35 per cent of the time is devoted to instruction, 45 per cent to administration, 15 per cent to extension and 5 per cent to experiment work. During the emergency the forester lectured on the use of wood as a war-time industry, assisted the New Hampshire Fuel Administrator and had charge of Map-Making in the Students' Army Training Corps course. He co-operated with the College Extension Service and the New Hampshire State Forester, and contributed one press bulletin and one extension bulletin in addition to contributions to the *Journal of Forestry*.

Two projects constitute the main Station work of the Department: The experiments in establishing artificial forests and the experiments in immature white pine stands.

EXPERIMENTS IN ESTABLISHING ARTIFICIAL FORESTS.

These experiments were started in 1912, when six sample plots were established to determine the conditions which are most favorable for the growth of various tree species.

The growth has been measured annually, and the following results are now apparent:

Of the species planted, Scotch pine, European larch and Norway spruce are growing thriftily.

These plantations are now all at least five years old. The white ash plantation died on account of excessive moisture. The average annual height growth is as follows:

European larch	8 inches	Red pine	3 inches
Scotch pine	6 inches	Douglas fir	3 inches
Norway spruce	5 inches		

Having passed the period of infancy, growth should be much more rapid in the future.

EXPERIMENTS IN IMMATURE WHITE PINE STANDS.

These experiments were started in 1912 when twenty-nine plots were established to determine best methods of thinning immature white pine stands. The plots are measured annually, and the following results are now apparent:

(a) White pine is seriously checked by overtopping hardwoods except, perhaps, gray birch.

(b) The removal of these overtopping hardwoods leads to an immediate increase in growth, provided it is not delayed too long.

(c) Data is being secured on the cost of such thinning at different ages.

(d) Pure stands of white pine are also being thinned and the cost (net and gross) determined at different ages.

REPORT OF THE DEPARTMENT OF HORTICULTURE.

J. H. GOURLEY.

DEPARTMENTAL ORGANIZATION.

The Department of Horticulture includes in its personnel at present the following:

Head of Department, J. H. Gourley.
Assistant Horticulturist, W. H. Wolff.
Assistant in Vegetable Gardening, J. R. Hepler.
Florist, James Macfarlane.
Foreman, Tony Teece.
Stenographer, Christina Collins.

The time of the members of the Department is divided approximately as follows:

	College	Adams	Hatch	Misc. Inc.	Other Source
J. H. Gourley	.5	.3	.2	.....	Greenhouse sales
W. H. Wolff	.5	.3	.2	.....	.....
J. R. Hepler	.7	.2	.1	.....	.....
James Macfarlane	.7	.....	.2	.....	.1
Tony Teece	PAID AS LABOR				
Christina Collins	.4	.2	.....	.2	.....

In addition to the general distribution of time, indicated in the above statement, it should be noted that a large correspondence comes to the Department, a large part of which is cared for by the head. Also two reading courses, one in Fruit Growing and one in Bee Keeping, are handled by W. H. Wolff, which require a considerable amount of time as there is a large registration in both. A reading course in Vegetable Gardening is handled by J. R. Hepler.

All members of the scientific staff of the Department are called upon for lectures away from the College, and at some seasons of the year this requires considerable outside time.

During the last year considerable writing of a popular nature was done by the staff in connection with the Food Campaign. This writing consisted of popular bulletins and newspaper articles.

Among other activities in the nature of special public services rendered should be mentioned the service of J. H. Gourley as State Garden Supervisor for the season of 1918, which required absence from the College more than half his time during the growing season. He also devotes some time throughout the year to the work of the State Horticultural Society.

The development of the physical plant of the Horticulture Department during the past two years has increased the work materially. Approximately 1,000 new fruit trees have been set and considerable new land put in to other crops.

HATCH PROJECTS.

Variety Tests.

This project has been continued from year to year as a means of determining the valuable sorts of fruits, especially small fruits for the state. It is of special value in connection with a study of hardiness of varieties. The work has been expanded somewhat owing to the fact that the new horticultural farm offers an opportunity to plant additional orchards and also to make more specific studies with small fruits. This latter work includes a fertilizer test and pruning work which has not previously been carried on.

The variety work with tree fruits and grapes is not on a large scale but is planned to give data with regard to certain of the more promising varieties that have not been tested heretofore at this Station.

Pruning of Apple Trees.

This project is planned with a view of determining the best form of a tree to grow in New Hampshire. There is much popular interest in this matter and the orchard is laid out as follows:

Block I—Pruned to vase-shaped trees.
II—Pruned to semi-leaders.
III—Pruned to leaders.
IV—Unpruned.

In a few cases, where two rows of trees are of the same variety, one row is one-year-old and the other two-year-old trees.

Peach Experiment.

This project is a simple fertilizer test with peach trees and is designed to give the growers of the state some information on the proper fertilizer to apply; especially how much nitrogen we can apply without danger of winter injury. Four varieties are in the test as follows: Elberta, Carman, J. H. Hale, and Belle of Georgia. This orchard was planted in 1917 but was badly winter-killed the following winter; it has, however made a remarkable recovery and the trees promise well.

Study of the Status of the Blueberry Industry in the State.

The propagation work with blueberries, which was attempted on a larger scale this season, did not meet with as much success when cuttings were made as when rooted plants were divided. Two boxes of cuttings were started in the greenhouse November 27, 1917. The boxes were moved out of doors to shade May 15, and by July 1 all but very few were dead. Those remaining alive were transferred to blueberry frames at the Horticultural Farm. A blueberry propagation frame, built and shaded similarly to the one at Whitesbog, N. J., was made at the Horticultural Farm, and in this 400 cuttings were planted. Another frame in natural shade on the north side of a barn was started also with approximately 400 cuttings. Of all these cuttings only a very few are alive today.

On the other hand, five bushes were transplanted into ordinary garden soil and these are living. No particular pains were taken in transplanting them: An old bush was simply dug up, separated into five parts, each with a piece of root, the tops were cut back, and these were set about as one would set a peach tree. It would, therefore, seem that no trouble is to be experienced in transplanting rooted plants.

MISCELLANEOUS PROJECTS.

Adaptation of Varieties of Tomatoes to New Hampshire Conditions.

This project has been continued, both inside and outside, during the year. It is expected that a publication will be issued in the course of the winter which will summarize the work.

Experiment on Use of Manures, Commercial Fertilizers and Green Crops for Maintaining Soil Fertility in a Vegetable Garden.

This project is outlined with one-eighth-acre plots as follows:

Plot 1. 32 T. of manure per acre.
Plot 2. 24 T. of manure per acre, with 150 lbs. tankage and 100 lbs. nitrate of soda, 600 lbs. acid phosphate and 150 lbs. muriate of potash.
Plot 3. 160 lbs. nitrate of soda, 250 lbs. tankage, 100 lbs. acid phosphate, 300 lbs. muriate of potash.
Plot 4. 16 T. manure.
Plot 5. Check.
Plot 6. 8 T. manure.
Plot 7. Green manure.

Half of these plots are to be limed every other year with one ton of ground limestone. This year the plots were in red kidney beans. They are situated on a farm that has been badly run down and very striking results were obtained showing the necessity of manure to bring up the land.

Experiment of Storage Pits and Trenches for Root Crops and Cabbage.

The experiments in pit storage were undertaken to determine the actual temperature inside the pit where the vegetables were stored; and care was taken to secure the same conditions as those under which the farmer would store vegetables. Two lots of vegetables, consisting of beets, carrots, and rutabagas, were put in pits under the surface of the ground; one of the pits was filled with two six-inch layers of hay and two of soil. The temperature was taken daily with an electrical thermometer, and bulbs were placed in the bottom of the pit under the vegetables as well as on top of the vegetables. The pits were made on November 15.

The heat from the vegetables raised the temperature of the pits so that it reached its maximum of 55° ten days after the closing of the pit. The temperature started dropping and reached a minimum of 35° on February 23, staying close to that mark until April 1, when the pits were opened. The temperature at the bottom of the pit was about 5° higher than the top. The vegetables were in fair shape, when taken out; about 75 per cent were salable.

Four lots of cabbage were also stored in trenches above ground. The first lot was covered with two layers of hay and five inches of soil; the second with two layers of hay and eight inches of soil; the third with a six-inch layer of soil and no hay; and the fourth with a two-inch layer of soil and three layers of hay. The maximum of the first pit was 42° November 25, and the minimum was 29° on December 15 and 27° on January 4. About 75 per cent of this cabbage was usable when removed. The second plot reached a minimum of 29° January 4; all this cabbage was usable when removed. Plot 3 reached a minimum of 23° on January 4; less than half the cabbage in the lot was usable. Plot 4 never went under freezing, although it reach 32° several times. All the cabbage in this pit was usable.

The conclusions drawn from this project were that if good cellar storage is available, the storing of roots in pits is hardly advisable, because the quality deteriorates faster than in cellar storage. When cabbage has proper protection, however, it comes out of the storage pit in better condition than when kept in cellar storage.

ADAMS PROJECTS.

Fruit Bud Formation.

This project was cared for in its essentials as outlined in previous reports and the data is being put in shape to summarize the ten-year average since the work started. Rather serious damage resulted to the orchard from the low temperature of the winter which caused the tops of the trees to show small leaves and stunted growth, and may result in the actual death of some of them

by another year. So far the number of branches actually killed has not been serious. Special information was collected along this line of winter injury throughout the state and New England, although it does not form a part of this project proper. The trees in this orchard will be so pruned as to grow a new top on the trees and will necessarily interfere with the yield of the plots for a time. The orchard was seeded to crimson clover and vetch as a substitute for crimson clover only, in order to secure more vegetation to turn into the land.

In addition to the regular work, some new phases of the work were commenced:

(1) *Light Studies.*—A tent or covering was erected over two Duchess trees in order to determine whether the fruit-bud formation could be affected by a reduced intensity of sunlight. In one case the covering was a muslin cloth and in the other of cheese cloth. Already a difference in the color of the foliage and coloring of the fruit can be seen depending upon the weight of the cloth covering; a decided contrast is also to be observed when the foliage under cover is compared with the foliage not so covered.

Soil temperature and air temperature records are being taken, and preparation is made for attempting to measure the intensity of the light under two covers as compared with the open.

(2) *Ringing and Root Pruning.*—Preliminary work was begun on the trees in the division rows of the Woodman Orchard to determine the effect of ringing the trunks and branches and of root pruning on trees of mature age in this climate. Trees were ringed two feet from the ground on April 28, June 8, June 28 and July 18, and the root pruning was done June 28. The wound did not heal on the tree which was ringed April 28; and on May 12 it was bridge-grafted in order to save the tree. In all cases the wounds healed and photographs have been made. The results of the operations cannot be seen until the spring of 1919 when more extensive work will be undertaken.

Inheritance in Color of Carnations.

This project has been continued as in the past and several new seedlings have been flowered and self-fertilized.

Mendelian Inheritance in Squashes.

This work which is now confined to two varieties, namely, Warren and Delicious, has given us more clear-cut results on dominance of the external characters, although intermediates have appeared in practically all the crosses we have made. Photographic records are made on the progress of this work. This spring we suffered the loss of most of our crop in the field, but the seed of each cross was saved so that the work can progress next year.

PUBLICATIONS OF THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION.

1888–1919.

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No. *134. Fertilizer Analyses, 1907. Morse, F. W., and Curry, Bert E. December, 1907. 8p.

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No. 152. Feeding Sheep and Lambs: Clover Hay v. Native Hay; Turnips v. Dry Ration.
No. 153. Fruit Bud Formation.
No. 154. Feeding Stuffs Inspection. (1911.)
No. 155. Fertilizer Inspection. (1911.)
No. 156. Results of Seed Tests.
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No. 162. Fertilizer Inspection. (1912).
No. 163. Twenty-third and Twenty-fourth Reports. 1911-1912.
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No. 165. The Feeding Stuffs Inspection for 1913.
No. 166. Results of Seed Tests. (1913.)
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No. 174. Seed Analyses for 1914.
No. 175. Analysis of Feeding Stuffs. (1915.)
No. 176. Analysis of Fertilizers. (1915.)
No. 177. Results of Seed Tests. (1915.)
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No. 190. Sod, Tillage and Fertilizers for the Apple Orchard.
No. 191. Inspection of Commercial Feeding Stuffs.
No. 192. Twenty-fifth Report

ANNUAL REPORTS.

†First Annual Report 1889. In the Eighteenth Report of the Board of Trustees of the New Hampshire College of Agriculture and Mechanic Arts. 1889. 99p.
†Second Annual Report 1890. In the Nineteenth Report of the Board of Trustees of the New Hampshire College of Agriculture and Mechanic Arts. 1890. p. 77-122.
Third and Fourth Annual Reports 1891-1892. In the Twentieth Report of Trustees of the New Hampshire College of Agriculture and Mechanic Arts. 1893. p. 137-287.
Fifth Annual Report 1893. In the Twenty-first Report of the Board of Trustees of New Hampshire College of Agriculture and Mechanic Arts. 1893. p. 85-241.
Sixth Annual Report 1894. In the Twenty-second Report of the Board of Trustees of New Hampshire College of Agriculture and Mechanic Arts. 1894. p. 118-173.
All subsequent reports of the Station appear as bulletins. See Bulletin list.
Nineteenth and Twentieth Reports. In the Twenty-ninth Report of the Board of Trustees of New Hampshire College of Agriculture and Mechanic Arts. 1908. p. 246-680.

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†Also published separately.

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No. *2. Testing Soils for Fertilizer Needs. Taylor, F. W. 1908.
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No. 15. Preparation of Bordeaux Mixture.
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No. 17. Spraying and Thinning Notes. (1914.)
No. 18. Blueberry in New Hampshire.
No. 19. Potato Seed Certification in New Hampshire.
No. 20. Storage of Potatoes.

SCIENTIFIC CONTRIBUTIONS.

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No. *3. The Oblique-banded Leafroller.
No. *4. The Relation of Temperature to the Growth of Insects.
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No. 13. Minimum, Optimum and Maximum Temperatures of Spore Germination in Some Uredinales.
No. 14. Relative Adhesiveness of the Copper Fungicides.

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